Table 19

Bell System Total Factor Productivity

Year	TFP Index	TFP Growth Rate
1947	.551	.000
1948	.570	.033
1949	.564	-.011
1950	.590	.045
1951	.619	.048
1952	.633	.023
1953	.639	.009
1954	.644	.008
1955	.678	.052
1956	.688	.014
1957	.724	.052
1958	.736	.016
1959	.780	.058
1960	.811	.039
1961	.829	.022
1962	.854	.030
1963	.874	.023
1964	.901	.031
1965	.927	.029
1966	.968	.043
1967	1.000	.033
1968	1.045	.044
1969	1.085	.038
1970	1.092	.006
1971	1.104	.011
1972	1.150	.040
1973	1.200	.043
1974	1.246	.037
1975	1.280	.028
1976	1.338	.044
1977	1.387	.036
1978	1.455	.048
1979	1.517	.042

Average Rate of Growth

	TFP
1947-61	.030
1961-79	.033
1947-79	.032

Table 20

Year	Aggregate Input: Quantity Index	Aggregate Input: Price Index	Rate of Growth
1947	5410.1	.472	.000
1948	5784.4	.518	.067
1949	6154.5	.535	.062
1950	6333.2	.563	.029
1951	6584.4	.615	.039
1952	6895.3	.670	.046
1953	7193.2	.686	.042
1954	7516.5	.699	.044
1955	7815.3	.738	.039
1956	8400.4	.751	.072
1957	8552.9	.743	.018
1958	8840.0	.768	.033
1959	9054.0	.811	.024
1960	9348.0	.846	.032
1961	9677.0	.880	.035
1962	10021.4	.900	.035
1963	10458.6	.909	.043
1964	10928.4	.965	.044
1965	11553.6	.970	.056
1966	12191.7	.981	.054
1967	12710.9	1.000	.042
1968	13238.9	1.043	.041
1969	14034.3	1.065	.058
1970	14926.5	1.106	.062
1971	15551.3	1.154	.041
1972	16124.2	1.250	.036
1973	16846.9	1.258	.044
1974	17369.4	1.334	.031
1975	17797.3	1.538	.024
1976	18299.0	1.711	.028
1977	19103.6	1.819	.043
1978	19981.0	1.962	.045
1979	20933.1	2.108	.047

	Average Rate of Growth of Aggregate Input	Ratio of Average Rate of Growth of Input to Output
1947-61	.042	.588
1961-79	.043	.561
1947-79	.042	.572

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Schedule 3

Total Productivity Growth in the U.S. Telecommunications Industry and the U.S. Economy, 1951 - 1987

Using data series that are readily available from government sources, one can measure total productivity for the U.S. telecommunications industry relative to the U.S. economy.

The first step in calculating total productivity is to determine the current dollar values of capital, labor, and materials inputs. The values for labor and capital come from a Bureau of Economic Analysis (BEA) publication, The National Income and Product Accounts of the United States, 1929 - 1982, which is updated annually in the BEA Survey of Current Business (SCB). Table 6.1 of the SCB shows gross national product originating in the telephone and telegraph industry. By accounting definition, gross national product equals the current dollar value of capital and labor combined. The value of labor is obtained from Table 6.4B, compensation of employees by industry. The current dollar value of capital is determined by subtracting labor compensation from gross national product originating in the telecommunications industry.

The value of materials input (purchases of goods and services other than capital and labor) cannot be determined from the data reported in the SCB, but it can be inferred from information reported to the FCC. By definition, the value of capital, labor, and materials input equals the value of output, or operating revenues. One can determine the ratio of operating revenues to the value of capital and labor for those companies reporting to the FCC, which can be applied to the industry value of capital and labor to obtain the industry value of materials input.

Data on companies reporting to the FCC are contained in the FCC

Statistics of Communications Common Carriers. Tables 14 and 15 of that document contain revenue and expense statements. Prior to divestiture the value of output was equal to total operating revenue; and the value of materials input was equal to total operating expense less operating rents, depreciation, compensation chargeable to operating expenses, and relief and pensions. The difference between operating revenues and the value of materials input is the value of capital and labor. Post-divestiture financial transactions between local exchange and inter-exchange carriers must be netted out to maintain consistency with pre-divestiture data. My Table 3-1 describes the calculations for the value of output and materials input pre- and post-divestiture.

Table 3-2 shows the resulting values of capital, labor, and materials inputs. Table 3-3 presents the shares in total cost for the figures in Table 3-2. The next step is to separate each of the values into price and quantity components. The quantity index of capital input is the telephone and telegraph constant dollar net stock of equipment and structures at beginning of year. This is published in the BEA publication Fixed Reproducible Tangible Wealth in the United States, 1925 - 1985 (Table A.2) and updated in the Survey of Current Business. The capital stock figures are presented in Table 3-4.

The quantity index of labor input used is the Bureau of Labor Statistics (BLS) index of employee hours in telephone communications, reported in Productivity Measures for Selected Industries and Government Services (Table 276). This quantity index is also presented in Table 3-4. The quantity index of materials input is obtained by dividing the value of materials input, shown in Table 3-2, by the GNP price index. The GNP price index and resulting quantity index are presented in Table 3-4.

Once the quantity indexes of capital, labor, and materials input are determined, the quantity index of total input is determined through the Tornqvist quantity index formula:

$$\begin{aligned} \ln \quad (Q_t/Q_{t-1}) = {} & 1/2\ (W_{Kt} + W_{K,t-1})\ \ln\ (Q_{Kt}/Q_{K,t-1}) \\ & + 1/2\ (W_{Lt} + W_{L,t-1})\ \ln\ (Q_{Lt}/Q_{L,t-1}) \\ & + 1/2\ (W_{Mt} + W_{M,t-1})\ \ln\ (Q_{Mt},/Q_{M,t-1}) \end{aligned}$$

Q represents the quantity index of total input, Q_K the quantity index of capital input, Q_L the quantity index of labor input, and Q_M the quantity index of materials input. The W's represent the value shares of capital, labor, and materials. The quantity index of total input is presented in Table 3-5.

The output index used is the BLS index of output for telephone communications, reported in Productivity Measures for Selected Industries and Government Services (Table 276). The index is presented in Table 3-5. Total productivity, which is the ratio of output to total input, is also presented in Table 3-5. The annual rates of growth of output, input, and total productivity can be computed by first-differencing the natural logarithms of the figures in Table 3-5. These growth rates are presented in Table 3-6.

The BLS provides annual figures on output, input, and total productivity for the private business sector of the U.S. economy. These figures, for 1951 through 1987, are presented in Table 3-7. The annual percentage growth rates for these figures are presented in Table 3-8.

The annual percentage growth rates of total productivity for the U.S. telecommunications industry relative to the U.S. economy are presented in

Table 3-9. The corresponding figures for output and input are also presented in Table 3-9.

Table 3-1

Determining the Values of Output and Materials
Input for Telephone Companies Reporting to the FCC

Output

Pre-divestiture: Total Operating Revenues

Post-divestiture: Total Operating Revenues
- Total Access Expenses
- Intrastate Billing and Collection Revenues
- Interstate Billing and Collection Revenues

Materials Input

Pre-divestiture: Total Operating Expenses
- Total Depreciation and Amortization Expenses
- Operating Rents
- Relief and Pensions
- Compensation Chargeable to Operating Expenses*

Post-divestiture: Total Operating Expenses
- Total Depreciation and Amortization Expenses
- Operating Rents
- Access Expenses
- Intrastate Billing and Collection Revenue
- Interstate Billing and Collection Revenue
- Relief and Pensions
- Compensation Chargeable to Operating Expenses*

*With divestiture, it is not possible to compute labor compensation from the FCC data. To impute compensation for later years, the rate of growth for telephone and telegraph compensation of employees (SCB, Table 6.4B) is applied to the 1983 sum of compensation chargeable to operating expenses and relief and pensions. Later-year relief and pensions is subtracted from this extrapolated value to impute compensation chargeable to operating expenses.

TABLE 3-2

Value of Capital, Labor, and Materials Input for the U.S. Telecommunications Industry

(billions of dollars)

	Value of Capital Input	Value of Labor Input	Value of Materials Input
1951	2.217	2.483	.625
1952	2.448	2.752	.689
1953	2.778	3.022	.743
1954	2.754	3.146	.790
1955	3.038	3.362	.865
1956	3.323	3.677	.991
1957	3.686	3.914	1.007
1958	4.225	3.875	.949
1959	4.922	4.078	1.054
1960	5.204	4.296	1.153
1961	5.758	4.442	1.258
1962	6.212	4.688	1.349
1963	7.004	4.896	1.511
1964	7.500	5.400	1.675
1965	7.984	5.916	1.900
1966	8.510	6.490	2.013
1967	9.531	6.969	2.184
1968	10.372	7.528	2.377
1969	11.353	8.647	3.151
1970	11.914	10.186	3.206
1971	12.965	11.335	3.521
1972	14.460	13.140	4.101
1973	16.165	14.535	4.207
1974	17.298	16.202	4.623
1975	19.269	17.531	5.043
1976	21.564	19.236	6.305
1977	22.859	21.141	7.676
1978	25.451	24.149	8.225
1979	26.098	27.602	8.595
1980	29.108	31.092	10.847
1981	33.435	35.565	13.378
1982	37.316	39.984	15.436
1983	46.000	40.800	15.835
1984	50.209	40.891	17.594
1985	56.505	41.795	18.762
1986	60.877	42.323	19.403
1987	64.144	44.156	18.982

TABLE 3-3

Input Cost Shares of Capital, Labor, and Materials for the U.S. Telecommunications Industry

Cost Share:	Capital	Labor	Materials
1951	.416	.466	.117
1952	.416	.467	.117
1953	.425	.462	.114
1954	.412	.470	.118
1955	.418	.463	.119
1956	.416	.460	.124
1957	.428	.455	.117
1958	.467	.428	.105
1959	.490	.406	.105
1960	.489	.403	.108
1961	.503	.388	.110
1962	.507	.383	.110
1963	.522	.365	.113
1964	.515	.370	.115
1965	.505	.374	.120
1966	.500	.381	.118
1967	.510	.373	.117
1968	.512	.371	.117
1969	.490	.374	.136
1970	.471	.403	.127
1971	.466	.407	.127
1972	.456	.415	.129
1973	.463	.416	.121
1974	.454	.425	.121
1975	.461	.419	.121
1976	.458	.408	.134
1977	.442	.409	.149
1978	.440	.418	.142
1979	.419	.443	.138
1980	.410	.438	.153
1981	.406	.432	.162
1982	.402	.431	.166
1983	.448	.398	.154
1984	.462	.376	.162
1985	.483	.357	.160
1986	.497	.345	.158
1987	.504	.347	.149

TABLE 3-4

Quantity Indexes of Capital, Labor, and Materials Input
for the U.S. Telecommunications Industry

(Normalized to 1.000 in 1987)

	Net Stock of Capital (Billions of 1982 dollars)	Quantity Index of Capital Input	Quantity Index of Labor Input	GNP Price Index	Quantity Index of Materials Input
1951	36	.206	.659	.251	.218
1952	38	.217	.684	.255	.237
1953	41	.231	.711	.259	.252
1954	44	.248	.712	.263	.263
1955	46	.262	.733	.272	.279
1956	49	.279	.777	.281	.309
1957	54	.305	.784	.291	.303
1958	58	.327	.736	.297	.280
1959	60	.341	.726	.304	.304
1960	63	.358	.732	.309	.327
1961	68	.383	.716	.312	.353
1962	72	.407	.718	.319	.371
1963	77	.433	.718	.324	.409
1964	82	.463	.744	.329	.446
1965	87	.492	.778	.338	.493
1966	93	.527	.822	.350	.504
1967	100	.565	.830	.359	.533
1968	106	.598	.845	.377	.553
1969	112	.634	.918	.398	.694
1970	120	.679	.972	.420	.669
1971	129	.732	.949	.444	.695
1972	137	.777	.989	.465	.773
1973	144	.817	1.022	.495	.745
1974	155	.874	1.043	.540	.751
1975	165	.931	.987	.593	.746
1976	171	.965	.973	.631	.876
1977	177	1.000	1.000	.673	1.000
1978	186	1.053	1.047	.722	.999
1979	200	1.129	1.103	.786	.959
1980	217	1.225	1.128	.857	1.110
1981	230	1.299	1.131	.940	1.248
1982	243	1.372	1.117	1.000	1.353
1983	252	1.427	1.010	1.039	1.336
1984	261	1.477	1.043	1.077	1.432
1985	272	1.538	1.026	1.109	1.483
1986	280	1.581	.991	1.138	1.495
1987	290	1.639	1.012	1.174	1.418

TABLE 3-5

Quantity Indexes of Output, Input, and Total Productivity for the U.S. Telecommunications Industy

(Normalized to 1.000 in 1977)

	Output	Input	Total Productivity
1951	.139	.336	.414
1952	.147	.353	.417
1953	.156	.371	.420
1954	.165	.384	.430
1955	.183	.401	.457
1956	.199	.429	.465
1957	.221	.446	.495
1958	.234	.444	.527
1959	.256	.454	.564
1960	.274	.470	.583
1961	.292	.486	.600
1962	.312	.504	.620
1963	.335	.526	.637
1964	.361	.558	.648
1965	.394	.591	.667
1966	.435	.627	.694
1967	.472	.656	.720
1968	.510	.683	.747
1969	.566	.746	.759
1970	.604	.784	.770
1971	.634	.809	.784
1972	.692	.857	.808
1973	.762	.885	.861
1974	.818	.922	.888
1975	.848	.926	.916
1976	.908	.955	.950
1977	1.000	1.000	1.000
1978	1.108	1.043	1.063
1979	1.222	1.092	1.119
1980	1.332	1.165	1.143
1981	1.407	1.217	1.156
1982	1.442	1.254	1.150
1983	1.466	1.221	1.201
1984	1.491	1.270	1.174
1985	1.537	1.294	1.188
1986	1.598	1.297	1.232
1987	1.679	1.319	1.273

TABLE 3-6

Annual Percentage Rates of Growth of Output, Input, and Total Productivity for the U.S. Telecommunications Industry

	Output	Input	Total Productivity
1952	5.6	4.9	.7
1953	5.9	5.2	.8
1954	5.9	3.4	2.4
1955	10.3	4.3	6.0
1956	8.4	6.6	1.8
1957	10.1	3.9	6.2
1958	5.8	-.5	6.4
1959	9.1	2.3	6.8
1960	6.8	3.5	3.3
1961	6.2	3.3	2.9
1962	6.9	3.7	3.2
1963	7.0	4.4	2.7
1964	7.5	5.8	1.7
1965	8.7	5.8	2.9
1966	9.9	5.9	4.0
1967	8.2	4.5	3.6
1968	7.7	4.0	3.7
1969	10.4	8.9	1.6
1970	6.5	5.0	1.5
1971	4.8	3.0	1.8
1972	8.8	5.8	3.0
1973	9.6	3.2	6.4
1974	7.1	4.1	3.0
1975	3.6	.5	3.1
1976	6.8	3.1	3.7
1977	9.7	4.6	5.1
1978	10.3	4.2	6.1
1979	9.8	4.7	5.1
1980	8.6	6.5	2.1
1981	5.5	4.4	1.1
1982	2.5	3.0	-.5
1983	1.7	-2.7	4.3
1984	1.7	3.9	-2.2
1985	3.0	1.9	1.2
1986	3.9	.3	3.6
1987	4.9	1.7	3.3
Averages:			
1951-87	6.9	3.8	3.1
1951-79	7.8	4.2	3.6
1979-87	4.0	2.4	1.6
1983-87	3.4	1.9	1.5
1975-87	5.7	3.0	2.7

TABLE 3-7

Quantity Indexes of Output, Input, and Total Productivity for the U.S. Economy

(Normalized to 1.000 in 1977)

	Output	Input	Total Productivity
1951	.437	.650	.672
1952	.451	.657	.686
1953	.472	.667	.708
1954	.464	.656	.707
1955	.496	.679	.730
1956	.511	.696	.734
1957	.516	.694	.743
1958	.506	.676	.748
1959	.543	.698	.778
1960	.553	.704	.785
1961	.563	.701	.803
1962	.593	.715	.829
1963	.620	.725	.855
1964	.658	.742	.887
1965	.699	.769	.909
1966	.735	.795	.924
1967	.754	.809	.932
1968	.788	.831	.948
1969	.810	.859	.943
1970	.802	.861	.931
1971	.824	.869	.948
1972	.877	.899	.975
1973	.930	.938	.992
1974	.912	.954	.956
1975	.893	.939	.951
1976	.945	.964	.980
1977	1.000	1.000	1.000
1978	1.058	1.045	1.012
1979	1.079	1.083	.996
1980	1.066	1.094	.974
1981	1.089	1.116	.976
1982	1.054	1.107	.952
1983	1.099	1.126	.976
1984	1.192	1.181	1.009
1985	1.243	1.214	1.024
1986	1.287	1.239	1.039
1987	1.334	1.274	1.047

TABLE 3-8

Annual Percentage Rates of Growth of Output, Input, and Total Productivity for the U.S. Economy

	Output	Input	Total Productivity
1952	3.2	1.1	2.1
1953	4.6	1.4	3.2
1954	-1.7	-1.6	-.1
1955	6.7	3.5	3.2
1956	3.0	2.4	.5
1957	1.0	-.2	1.2
1958	-2.0	-2.6	.7
1959	7.1	3.1	3.9
1960	1.8	.9	.9
1961	1.8	-.5	2.3
1962	5.2	2.0	3.2
1963	4.5	1.4	3.1
1964	5.9	2.3	3.7
1965	6.0	3.6	2.5
1966	5.0	3.4	1.6
1967	2.6	1.7	.9
1968	4.4	2.7	1.7
1969	2.8	3.3	-.5
1970	-1.0	.3	-1.3
1971	2.7	.9	1.8
1972	6.2	3.4	2.8
1973	5.9	4.1	1.7
1974	-2.0	1.7	-3.7
1975	-2.1	-1.6	-.5
1976	5.7	2.7	3.0
1977	5.7	3.6	2.0
1978	5.6	4.4	1.2
1979	2.0	3.6	-1.6
1980	-1.2	1.0	-2.2
1981	2.1	1.9	.2
1982	-3.3	-.8	-2.5
1983	4.2	1.7	2.5
1984	8.1	4.8	3.3
1985	4.2	2.7	1.5
1986	3.5	2.0	1.5
1987	3.6	2.8	.8
Averages:			
1951-87	3.1	1.9	1.2
1951-79	3.2	1.8	1.4
1979-87	2.7	2.0	.6
1983-87	4.8	3.1	1.8
1975-87	3.3	2.5	.8

TABLE 3-9

Annual Percentage Rates of Growth of Output, Input, and Total Productivity for the U.S. Telecommunications Industry less the Corresponding Rates of Growth for the U.S. Economy

	Output	Input	Total Productivity
1952	2.4	3.8	-1.4
1953	1.3	3.8	-2.4
1954	7.6	5.0	2.5
1955	3.6	.8	2.8
1956	5.4	4.2	1.3
1957	9.1	4.1	5.0
1958	7.8	2.1	5.7
1959	2.0	-.8	2.9
1960	5.0	2.6	2.4
1961	4.4	3.8	.6
1962	1.7	1.7	.0
1963	2.5	3.0	-.4
1964	1.6	3.5	-2.0
1965	2.7	2.2	.4
1966	4.9	2.5	2.4
1967	5.6	2.8	2.7
1968	3.3	1.3	2.0
1969	7.6	5.6	2.1
1970	7.5	4.7	2.8
1971	2.1	2.1	.0
1972	2.6	2.4	.2
1973	3.7	-.9	4.7
1974	9.1	2.4	6.7
1975	5.7	2.1	3.6
1976	1.1	.4	.7
1977	4.0	1.0	3.1
1978	4.7	-.2	4.9
1979	7.8	1.1	6.7
1980	9.8	5.5	4.3
1981	3.4	2.5	.9
1982	5.8	3.8	2.0
1983	-2.5	-4.4	1.8
1984	-6.4	-.9	-5.5
1985	-1.2	-.8	-.3
1986	.4	-1.7	2.1
1987	1.3	-1.1	2.5
Averages:			
1951-87	3.8	1.9	1.9
1951-79	4.6	2.4	2.2
1979-87	1.3	.4	1.0
1983-87	-1.4	-1.2	-.3
1975-87	2.4	.5	1.9

Schedule 4
Calculation of 1991 ICI

Year	Quarter	GNP-PI
1988	3	124.7
	4	126.1
1989	1	127.6
	2	129.0
Average		126.85
1989	3	130.0
	4	131.2
1990	1	133.3
	2	134.6
Average		132.275

Year	Average GNP-PI	Percent Change	Index
1988-89	126.85	--	1.0000
1989-90	132.275	4.28	1.0428

source: Survey of Current Business, July 1990.

Schedule 5

Updating the Productivity Incentive Adjustment

The formula that I recommend for computing the Productivity Incentive Adjustment (PIA) for U.S. West is as follows:

> The rate of growth of total productivity for U.S. telecommunications industry as defined in Schedule 3 (averaged over the time period determined by the North Dakota Commission)
>
> minus
>
> The rate of growth of "multifactor" productivity reported by the U.S. Bureau of Labor Statistics for the private business sector of the U.S. economy (averaged over the same time period as for the U.S. telecommunications industry).

The PIA that I derived in Schedule 3 for U.S. West for 1991 is based entirely on U.S. government data sources for 1975 through 1987. The Commission could use the same PIA for several years, as Dr. Dobesh and I have both recommended. If, however, the Commission wished to "update" the PIA each year by utilizing newly available data and deleting the oldest data, it would be straight forward to do so. The methods in Schedule 3 can be used with the revised data set. For example, to compute the 1992 PIA 1975 data could be deleted and 1988 data added. Currently, several of the required data series are not available through 1988. But, with one exception, they should all be available prior to the end of 1991.

The one data series that would require special treatment is the value of materials input for the U.S. telecommunications industry. The accounting format underlying the FCC's Statistics of Communications Common Carriers underwent a substantial change in 1988, with the result that this document cannot provide a value for materials input in 1988.

Table 3-3 in Schedule 3 shows that the materials input share in the cost of total input for U.S. telecommunications was very stable from 1977

through 1987. For this eleven-year period the materials cost share averaged .154. Therefore, it would be reasonable to project the materials cost share at .154 for the next several years. With this projection the data and methods in Schedule 3 could be used to update the PIA for several future years.

North Dakota Public Service Commission
Case No. PU-2320-90-149

U S WEST COMMUNICATIONS

RESPONSIVE TESTIMONY

OF

LAURITS R. CHRISTENSEN

OCTOBER 15, 1990

Case No. PU 2320-90-149

Responsive Testimony of Laurits R. Christensen

Q. Is there any historical evidence to support Dr. Dobesh's contention that USWC total productivity in North Dakota will increase 7% more than total productivity in the U. S. economy in 1991?

A. No, there isn't. As Table 3-9 of my direct testimony shows, the historical experience varies greatly from year to year. But in no year in the past forty has the total productivity growth differential ever been as high as 7%. The average has been 1.9%.

Q. Do you agree with Dr. Dobesh that recent total productivity performance by the U.S. telecommunications industry is more relevant to the current proceeding than performance for prior years?

A. Yes, I do.

Q. What is the largest increase in total productivity by the U.S. telecommunications industry relative to the U.S. economy since divestiture at the end of 1983?

A. The largest increase has been 2.5%, which my Schedule 3 shows occurred in 1987.

Q. On average, was the total productivity growth differential higher before or after divestiture?

A. The total productivity growth differential was much higher before divestiture: 2.2% per year before divestiture vs. -.3%

per year after divestiture.

Q. Isn't that surprising given the rapid growth and technological change in the U.S. telecommunications industry in recent years?

A. No. Output in the U.S. telecommunications industry has indeed been growing, but at a far slower pace than prior to divestiture. From 1951 through 1983, output grew at an average annual rate of 7.4% per year. This rate of growth was so high that output was more than ten times as great in 1983 as it had been in 1951. Since 1983 output has grown rapidly, 3.4% per year, but much less rapidly than previously. Technological change has proceeded for the telecommunications industry. But there is no evidence that it is proceeding more rapidly than in previous years.

Furthermore, it is important to recognize, as Dr. Dobesh does, that it is the total productivity growth differential between the telecommunications industry and the U.S. economy that is relevant. Total productivity growth for the U.S. economy has been much stronger in recent years and, in my opinion, will remain stronger for years to come. Therefore, it will be more difficult than in the past for the telecommunications industry to achieve a high total productivity differential relative to the U.S. economy.

Q. In his direct testimony, Dr. Dobesh cites BLS productivity numbers to support a higher total productivity growth

differential than your Schedule 3 shows. Do you agree that the BLS figures indicate a higher differential than your study shows?

A. No, I do not. The BLS figures are not directly relevant because they are labor productivity figures rather than total productivity figures.

But even though they are not directly relevant, there is no conflict between the BLS labor productivity figures and my own study of total productivity in the telecommunications industry. The total productivity growth rates that I have computed are simply the BLS labor productivity growth rates adjusted to total productivity by taking into account capital and materials inputs--as dictated by the North Dakota statute.

Q. Dr. Dobesh has argued that because he is looking at the productivity growth <u>differential</u>, no bias results from his use of labor productivity rather than total productivity. Do you agree?

A. No, I do not. There is a very large bias that results from the use of labor productivity. For the U.S. economy, both labor and non-labor inputs have been growing. But for the telecommunications industry, labor input has fallen in recent years--rather than growing with non-labor inputs. Therefore, the differential in labor productivity growth will be a biased proxy for total productivity growth.

It would only be a coincidence if the total productivity growth differential (the relevant concept) were the same as the

labor productivity growth differential (an irrelevant concept). I have reported in Schedule 3 of my direct testimony the results of studying the relevant concept. Dr. Dobesh has not attempted to measure the relevant concept. Rather, he has relied on BLS figures for an irrelevant concept and argued that the results would be the same if he were to use the relevant concept.

The argument is false. The growth of labor input understates the growth of total resource use for both the telecommunications industry and the U.S. economy. Therefore, labor productivity growth overstates total productivity growth for both the telecommunications industry and the U.S. economy. But the overstatement is far greater for the telecommunications industry.[1] And, hence, the labor productivity growth differential far exceeds the total productivity growth differential.

For the 1983-1987 post-divestiture period, the labor productivity growth differential has been 1.4% and the total productivity growth differential has been -.3%.[2] Clearly, the

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[1]There are two reasons for this. First, labor input in the telecommunications industry has deviated more from the growth of non-labor inputs than for the U.S. economy. Second, this bigger deviation is magnified by the fact that labor input is only 35% of total resource cost in the telecommunications industry (vs. 65% for the U.S. economy).

[2]The total productivity differential of -.3% per year is from Table 3-9 of my direct testimony. The labor productivity growth differential of 1.4% per year can be computed directly from Schedule 3 of Dr. Dobesh's testimony. Telecommunications labor productivity growth = (ln (165.9/145.1))/4 = 3.35%. Business sector labor productivity = (ln (111.1/102.6))/4 = 1.99%. The difference is 1.4% per year.